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Laser-based fabrication and modification of plasmonic nanostructures for optical applications.

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Invited

ABSTRACT

The increasing demand for material functionalities beyond the supply offered by nature has boosted the search for artificially designed materials with improved performance. In the case of optics and photonics, plasmonics is a promising concept to develop new technologies and applications such as optical active devices, sensors or photovoltaic cells. Plasmonic structures with characteristic dimensions in the range of a few nanometers are based on the combination of noble metals and dielectrics, as for instance metal nanoparticles (NPs) immersed in a dielectric matrix. They present unique optical properties that are dominated by an enhanced absorption at the Surface Plasmon Resonance wavelength that depends on the size, shape and organization of NPs.

This presentation reviews the application of ns- and fs-laser based techniques to produce plasmonic nanostructures and tailor their optical response. Alternate ns-Pulsed Laser Deposition allows nanometric control over the structures as well as reduced NP size dispersion. However, the Volmer-Weber NPs growth mode along with surface processes such as sputtering or sub-surface implantation associated to the presence of a significant fraction of energetic ions in the laser generated plasma hinder the production of NPs with well-defined symmetry axes and play a crucial role on the overall properties of the nanostructures. These shortcomings can be tackled using ns- and fs-laser postprocessing, able to change the shape and spatial distribution of NPs, as well as to produce aligned structures.

This approach will be illustrated in nanostructures containing layers of Au or Ag NPs. We will focus on the experimental parameters that have a direct impact on the morphology of the NPs and their effect on the optical properties of the nanocomposites. Finally, the potential of laser-produced nanostructures will be demonstrated through applications in which a controlled optical response remains essential for efficient performance, such as light modulation, photovoltaics and SERS.